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ABSTRACT

The optimal allocation of Air Force talent requires, among other considerations, the measurement of both enlistee aptitudes and job aptitude requirements. Although objective procedures are available to measure aptitudes accurately, the procedure presently employed for establishing relative aptitude requirements is both unsystematic and subject to influence by extraneous factors. The Air Force Human Resources Laboratory has developed a systematic procedure for inferring relative aptitude requirements. It is based on occupational information collected at the task level. The measure issuing from this procedure is referred to as learning difficulty and represents the time it takes to learn to perform an occupation satisfactorily. The steps in the development of this procedure are (1) collecting supervisors' ratings of task difficulty, (2) obtaining benchmark task difficulty ratings from independent experts, and (3) analyzing these ratings for reliability and validity. Using this procedure, measures of occupational learning difficulty have been produced for more than 200 enlisted occupations or Air Force specialties. Use of these more refined measures of task assignment via aptitude measures may result in a more efficient use of Air Force personnel and ultimately cut down on attrition caused by job boredom. (Author/KC)

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The Development and Application of Measures of Occupational Learning Difficulty

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One of the major organizational goals of the Air Force and one of the greatest challenges for Air Force management is the optimal allocation of talent. The most talented enlistees must be assigned to the most demanding occupations. Historically, Air Force occupational classification has been accomplished by reference to measures of enlistees' aptitudes. Today, entry into enlisted occupations is largely governed by minimum aptitude requirements expressed in terms of percentile score cut-offs on the mechanical, administrative, general, or electronics aptitude index of the Armed Services Vocational Aptitude Battery (Weeks, Mullins, and Vitola, 1975). The problem which serves as the subject of this presentation concerns misalignments in the levels of minimum aptitude requirements as presently established by Air Force Regulation (Note 1, Air Force Regulation 39-1).

Originally, aptitude requirements were established on the basis of expert judgment; however, once they were available more rigorous and defensible procedures were adopted. Today aptitude requirements are established and modified on the basis of studies of the relationship between enlistees' aptitudes and their performance in Air Force technical training. Correlations between different aptitude indexes and measures of training performance are examined to identify the most appropriate aptitude index to use for stating minimum aptitude requirements. The aptitude index having the greatest relationship with training performance is considered most indicative of training success and therefore most appropriate for specifying occupational aptitude requirements. After the aptitude type is determined, the minimum level of aptitude is established by reference to training course pass/fail rates (Maginnis, Uchima, & Smith, 1975a, 1975b, 1975c). For example, high course failure rate is considered a sufficient basis for increasing the level of the associated aptitude requirement. Although this approach appears to be both reasonable and defensible, it has serious deficiencies. The major problem is that standards of successful training performance appear to vary from course to course. Nevertheless, pass-fail rates are considered comparable when used for establishing minimum aptitude requirement levels. To further aggravate the problem, unsuccessful trainees may be recycled through the training course until they are successful. This transforms a training failure into a training success and directly changes the course pass/fail rate so that it is confounded with training time. In summary, course pass/fail rate is both a non-standardized and a confounded measure of training performance and, as such, is a totally unsatisfactory basis for setting minimum aptitude requirement levels.

Scope of Problem

The problem has both an extensive and critical impact on the Air Force personnel system. Its effect is not limited to the training arena. There are immediate effects on personnel procurement. For example, when aptitude requirements are lowered the number of eligible applicants for a given

occupation typically increases. Alternatively, when aptitude requirements are raised, the number of eligible applicants decreases. The adjustment of aptitude requirements has a direct effect on occupational selection ratios.

In addition, inappropriately established aptitude requirements can have an adverse impact on job attitudes. Locke (1976) suggests that individuals assigned to jobs that do not fully utilize their talents tend to experience boredom. On the other hand, individuals assigned to jobs that require more talent than they have tend to experience frustration. To the extent that boredom and frustration contribute to job dissatisfaction, a lack of correspondence between the demands of the job and the associated aptitude requirement may indirectly contribute to increased attrition and decreased retention. Clearly, occupational aptitude requirements are critical parameters in personnel procurement, training, and utilization. Every effort must be made to insure that they are established systematically and with reference to the most accurate, empirical information available.

Approach

In the early 70's, the Air Force Manpower and Personnel Center requested that the Air Force Human Resources Laboratory (AFHRL) conduct research to develop a more objective means of establishing relative aptitude requirements. In response to this request, research was initiated which was based on the philosophy that the occupation, rather than the training course, was the most desirable source of information for making decisions concerning aptitude requirements. The proposed approach to setting relative aptitude requirements involved the derivation of measures of the learning difficulty associated with each enlisted occupation. These measures of occupational learning difficulty were to serve as the frame of reference for inferring relative aptitude requirements for occupations in the same aptitude area; that is, occupations having a common aptitude requirement type. Notice that the emphasis is on relative levels of aptitude requirements; the determination of aptitude requirements in absolute terms was not considered to be an attainable goal given the state of the art.

In this context, occupational learning difficulty was defined as the time it takes to learn to perform an occupation satisfactorily. This definition was adopted only after research (Mead, 1970a, 1970b; Mead and Christal, 1970; and Leczrar, 1971) indicated that work supervisors achieved a high level of agreement about learning difficulty when it was defined in terms of learning time. After this definitional problem was resolved, the next major issue involved the relationship between learning difficulty and aptitude. The importance of this relationship originates with the proposal that learning difficulty be used as the standard for inferring relative aptitude requirements. Clearly, this assumption is basic to the entire approach. Christal (1976) argues that indirect evidence in support of the relationship issues from training research. He indicates that when training time is constant, the amount of material mastered is positively related to aptitudes. Alternatively, when students are trained to some standard of performance and are allowed to progress through training at their own rate, training time is negatively related to aptitudes. Direct evidence of the relationship between time to learn occupational tasks and required task aptitude was provided by Fugill (1972). He reported correlations that range from .89 to .93 between supervisors' judgments of time to learn occupational tasks and behavioral scientists' judgments of the aptitude required to insure satisfactory performance of the tasks. Fugill (1972) concluded that relative task aptitude

was conceptually inseparable from relative task difficulty when difficulty is defined in terms of learning time. Additional evidence in support of the relationship between aptitude and learning rate is readily available in the area of educational research. Studies by Krumboltz (1965), Cronbach and Snow (1977), Block and Anderson (1975), and Gettinger and White (1979) all lend support to the notion that aptitudes are related to learning time.

Once the general strategy was adopted, the next step was the development and application of a procedure to obtain measures of occupational learning difficulty. The procedure that was developed is both highly technical and relatively complicated. Although only a brief summary of the procedure will be provided, detailed technical discussions are available in a formal report by Burtch, Wissman, and Lipscomb (1981), and in a paper presented by Weeks and Wissman (Note 2, 1980) at the Third International Occupational Analysts Conference.

The initial step in determining the learning difficulty of an occupation is to perform an occupational analysis. The occupational analysis technique employed was the task inventory approach supplemented by the Comprehensive Occupational Data Analysis Programs (CODAP). This technique consists of first having job experts analyze occupations into distinct functional areas of interrelated activities (e.g., duties) and then having them further analyze duties into meaningful units of work recognizable to the worker (e.g., tasks). This technique is routinely employed by the Air Force Occupational Measurement Center (USAFOMC) to develop task inventories descriptive of Air Force occupations. Task inventories are then used to survey occupational incumbents to obtain ratings of the time spent on tasks they perform and to survey occupational supervisors to obtain task by task ratings of learning difficulty.

In deriving measures of occupational learning difficulty, task time spent ratings and task difficulty ratings collected by USAFOMC were two of three different types of occupational information employed. The third type of occupational information was obtained through contract with a private research firm. Private contractors also provided ratings of task learning difficulty. These additional task ratings were needed because work supervisors' task difficulty ratings were not comparable across occupations. Supervisors' task ratings provided information concerning the relative order of tasks within occupations. This stems from the fact that supervisors used simple, relative rating scales in rating task difficulty. Contractors, on the other hand, provided ratings of task learning difficulty which were based on task anchored, benchmark rating scales (Burtch, Wissman, and Lipscomb, 1981). The benchmark rating scales were designed to capture the range of learning difficulty characteristic of all tasks in all occupations in an aptitude area and, as a result, yielded ratings of task learning difficulty that were comparable across occupations. Benchmark task ratings were collected for the ultimate purpose of adjusting supervisors' task ratings so that they would be comparable across occupations.

In obtaining benchmark task difficulty ratings, an unusually rigorous set of requirements were imposed. The contractor was required to select raters who had expert knowledge of occupations in each aptitude area. Next, the raters were intensively trained in the application of the benchmark rating scales. To help in the training process, procedural guides were developed which provided detailed information concerning the steps to be followed in the actual rating process, the criteria to be used in assessing task learning

difficulty, and the interpretation of the anchor tasks which define the level of difficulty associated with each point on the benchmark rating scales.

In the application of a benchmark scale to tasks from a selected occupation, the first step was to interview instructors of training courses associated with the occupation. Interviews were conducted to clarify misunderstandings concerning task statements and to collect information concerning the equipment used in task performance. After training instructor interviews were completed, the contractor raters were divided into two teams. Each rating team visited a different operational site to interview occupational incumbents and gather additional information concerning the task assessment criteria. After becoming thoroughly familiar with both the tasks to be rated and the benchmark scale anchor tasks, each team member independently provided benchmark ratings of task learning difficulty.

The final step in the rating process was to analyze the ratings for reliability and validity. If established standards of reliability and validity were attained, benchmark task ratings were then averaged across raters and used to adjust average task ratings of learning difficulty provided by occupational supervisors. The final product was an adjusted learning difficulty rating for each task in the job inventory. Adjusted learning difficulty ratings are, therefore, based on judgments from both occupational supervisors and independent experts and can be used to compare the difficulty of tasks both within and across occupations.

Results

Examples of the reliability of both benchmark and supervisor ratings are provided in Table 1. Using the intraclass correlation technique described by Lindquist (1953), estimates of interrater reliability were calculated. The Spearman-Brown formula was then employed to obtain estimates of reliability for 14 raters per task for the benchmark ratings and for 40 raters per task for the supervisor ratings. Table 1 presents the range and median R_{kk} values for several occupations in each aptitude area. These data indicate that high agreement can be achieved by both occupational supervisors and independent experts when scaling tasks along the dimension of learning difficulty.

Table 1. Interrater Reliability of Supervisor and Benchmark Ratings of Task Learning Difficulty

Aptitude Area	Summary Statistics			
	Benchmark Ratings		Supervisor Ratings	
	Range of R_{kk}	Median R_{kk} Value	Range of R_{kk}	Median R_{kk} Value
Mechanical	.89 - .98	.95	.93 - .97	.96
Electronics	.94 - .98	.97	.93 - .99	.96
General/ Administrative	.93 - .98	.96	.93 - .98	.96

Note. Reliability statistics are provided for 25 mechanical occupations, 18 electronics occupations, and 55 general/administrative occupations.

The accuracy of the benchmark rating procedure was confirmed by convergent validation (Campbell and Fiske, 1959). Correlations between relative ratings of task learning difficulty provided by occupational supervisors and benchmark ratings of task learning difficulty provided by the independent experts were derived for occupations in each aptitude area. The range of correlations and median correlation obtained in each aptitude area is presented in Table 2. These data suggest convergence of judgments of task learning difficulty by independent methods and from independent sources and provide evidence in support of the validity of the benchmark rating procedure.

Table 2. Correlations between Supervisor and Benchmark ratings of Task Learning Difficulty

Aptitude Area	Range of r	Median r	N Occupations
Mechanical	.58 - .88	.81	25
Electronics	.54 - .96	.84	18
General/ Administrative	.54 - .95	.77	55

Once adjusted ratings of learning difficulty were available for all tasks in the inventory, the next step was to develop a procedure for combining them to represent the learning difficulty of the entire occupation. It was decided that a weighted sum of all tasks in the inventory was the most desirable approach. Also, because tasks are performed different amounts of time by different incumbents within the same occupation, learning difficulty was derived on an incumbent by incumbent basis. In so doing, the adjusted learning difficulty rating for a given task is weighted by the percent of time spent performing that task by a given incumbent. The sum of these products for all tasks performed by the incumbent is divided by a scaling factor and is considered the index of learning difficulty for that incumbent's position. To derive a global measure of learning difficulty representative of an occupation, learning difficulty indexes can be averaged across the incumbent population or any specified incumbent sample. For the purposes of this research, estimates of occupational learning difficulty were produced by averaging across incumbents in the first term of service. This procedure was dictated by the objective of the research and the management policy of assigning occupational aptitude requirements so that they correspond to entry level positions.

To date, measures of occupational learning difficulty have been produced for over two hundred enlisted occupations or Air Force specialties (AFSCs). For example, Figure 1 presents the relative order of learning difficulty of sample occupations in the general/administrative aptitude area and the associated minimum aptitude requirement as they are listed in Air Force Regulation 39-1 (Note 1, 1981). The horizontal bar next to each occupation represents ± 1 standard deviation about the mean learning difficulty for that occupation. The vertical hashmark on each bar represents the mean. The

position of the bar along the horizontal dimension indicates the relative learning difficulty of the occupation with bars located on the right side of the figure being higher in learning difficulty than bars located on the left. Comparisons of the relative order of learning difficulty with the relative order of aptitude requirements indicate misalignments of aptitude requirements with respect to learning difficulty. For example, weather specialist is assigned a higher aptitude requirement than contracting specialist even though the learning difficulty of the weather specialist occupation is lower than that for contracting specialist. Also, note that the learning difficulty for air passenger specialist and materiel facilities specialist is the same; yet, the associated aptitude requirements are different. This example is useful in demonstrating the major limitation associated with the use of occupational learning difficulty for inferring relative aptitude requirements. Although learning difficulty provides a valuable reference point for evaluating relative aptitude requirements, it provides no basis for inferring absolute aptitude requirements. Accordingly, we can conclude that the aptitude requirement for air passenger specialist and materiel facilities specialist should be the same but we can make no legitimate inferences with respect to whether the aptitude requirement should be either 40 or 50.

In addition to revealing inaccuracies in the relative levels of aptitude requirements, Figure 1 also indicates that the variability in learning difficulty is quite different from one occupation to the next. For example, the variability of learning difficulty for weather specialist is nearly twice the variability of learning difficulty for contracting specialist. This suggests the possibility of restructuring the weather specialist occupation into two separate jobs, each having different aptitude requirements, and/or redesigning the occupation or occupational tasks so that the associated learning difficulty is less variable.

Conclusions

A number of different conclusions can be based on these results. First, knowledgeable judges can reach high levels of agreement concerning the relative learning difficulty of work tasks when learning difficulty is defined in terms of learning time. This was demonstrated in situations where judgments were provided by work supervisors and in situations where judgments were provided by independent experts. Second, benchmark rating scales were designed to capture the range of learning difficulty of all tasks in an aptitude area. The data indicate that the proper application of the benchmark rating scales produced valid measures of task learning difficulty. This was demonstrated by showing substantial convergence between supervisors' judgments of task difficulty based on relative rating scales and independent experts' judgments of task difficulty based on benchmark rating scales. Third, there is some degree of inaccuracy in the occupational aptitude requirements stated in Air Force Regulation 39-1 (Note 1, 1981). This was demonstrated by showing that some occupations assigned high aptitude requirements were found to be of lower learning difficulty than other occupations assigned lower aptitude requirements. Fourth, the variability in learning difficulty of entry level positions in some occupations is so great that occupation specific investigations appear to be warranted to determine the desirability of job restructuring and/or job redesign.

In general, it appears that the talent available to the Air Force is not being allocated in the most optimal manner. This may have been a relatively minor problem in the past; the Air Force has encountered few difficulties in recruiting its share of the available talent. However, projected decreases in

the number of available applicants in primary recruiting age groups suggest a growing urgency of this problem and the need for a more refined method of assigning aptitude requirement minimums.

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RELATIVE APTITUDE REQUIREMENTS FOR FIRST-TERMER JOBS

APT

REQ OCCUPATION

OCCUPATIONAL LEARNING DIFFICULTY

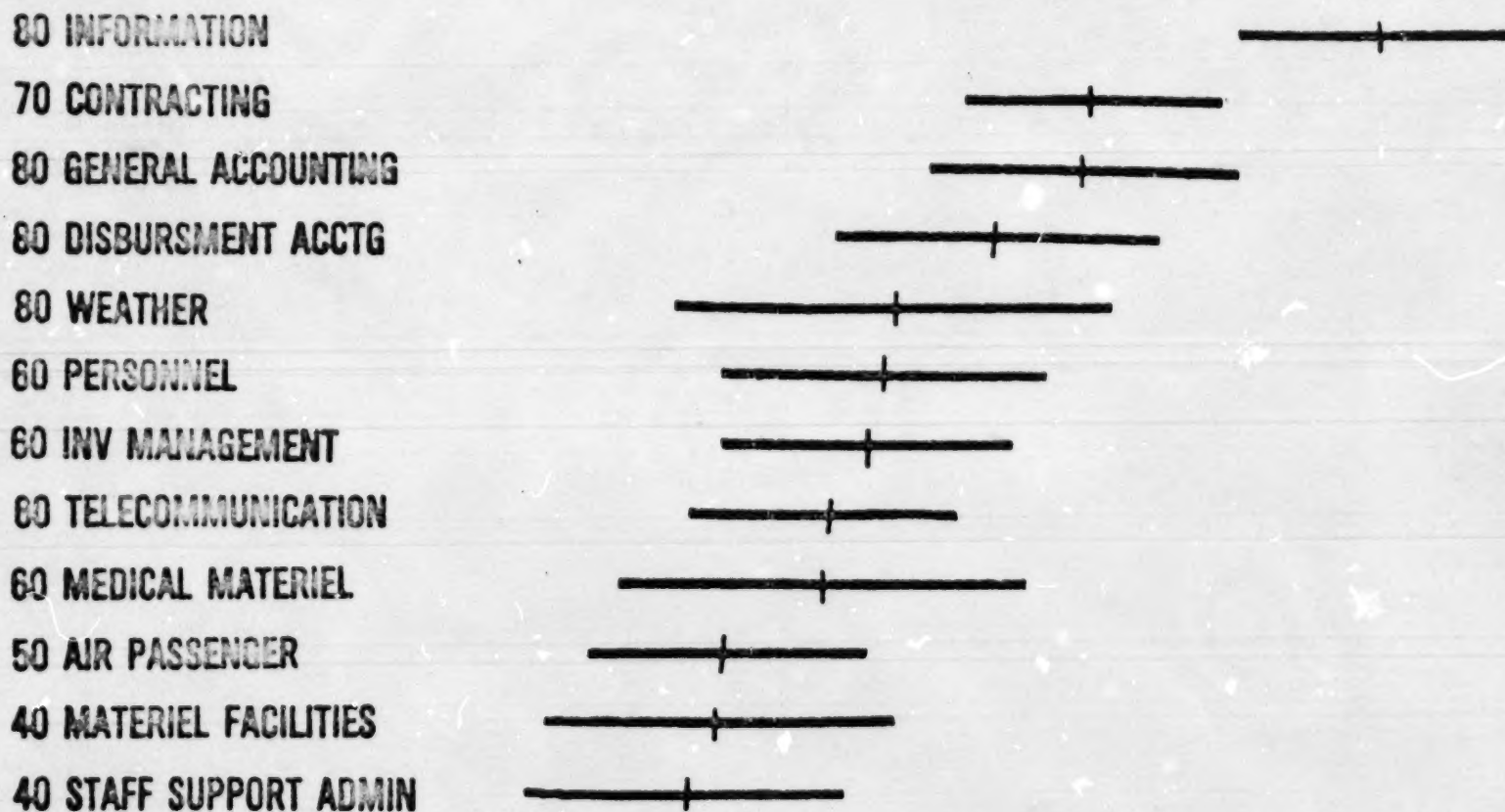


Figure 1. RELATIVE ORDER OF OCCUPATION LEARNING DIFFICULTY FOR A SAMPLE OF OCCUPATIONS